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ABSTRACT

This booklet describes the water resources in Virginia. Main sections included are: (1) "Introduction" (providing a general overview of the richness and diversity of Virginia's water resources both economic and recreational); (2) "River Basins" (illustrating the area drained by nine rivers and their tributaries); (3) "Bays" (including the Chesapeake and Back Bays); (4) "Lakes" (describing the state's two major natural lakes and its many reservoirs); (5) "Groundwater" (presenting information on five physiographic provinces); and (6) "Management." The booklet is illustrated with numerous color photographs and several maps. (YP)

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Virginia's Waters

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What is it about Virginia?

There is the name. Virginia. It sings itself . . . .

The very land is in the name.
In the sweet, undulating roll of Virginia,
you can catch the soft folds of the Blue Ridge Mountains
in the morning mist . . . .

The major rivers rise and make their way to the Chesapeake Bay
without ever leaving Virginia.
They know. Why leave? they ask.
Life is good around us.

--Guy Friddell
What Is It About Virginia?

Virginia's Waters

By
Kathryn P. Sevebeck,
Jacob H. Kahn,
and Nancy L. Chapman

Photographs by Jacob H. Kahn

Virginia Water Resources Research Center
Virginia Polytechnic Institute and State University
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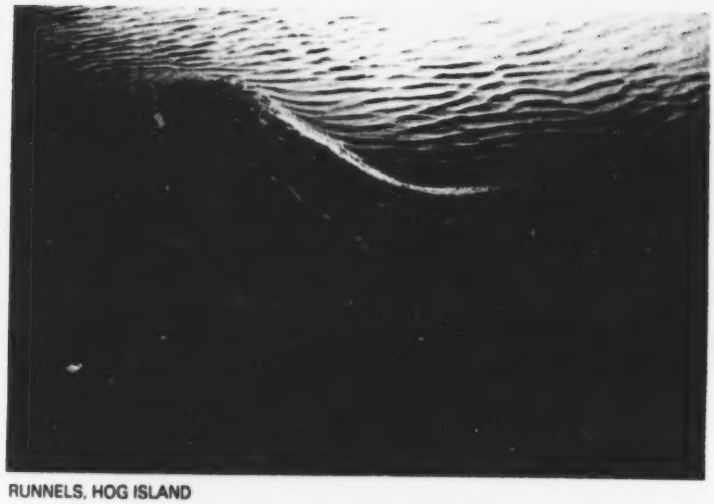

RUNNELS, HOG ISLAND

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Introduction

VIRGINIA is rich in water resources. It has 976 square miles of surface water, including lakes, tidal rivers and bays, and more than 3,000 miles of nontidal rivers and streams. There are more than 450 public fishing streams, 1,500 miles of stocked trout streams, and an estimated 50,000 small farm ponds and lakes. Under the protection of the Virginia Scenic Rivers Act, 225 miles of state waters have been given Scenic River designations.

To the east, the Commonwealth has more than 5,000 miles of shoreline on the Atlantic Ocean and the Chesapeake Bay. To the north, the Potomac River serves as Virginia's boundary with Maryland and the District of Columbia. Two of the state's largest reservoirs, Lake Gaston and Buggs Island, straddle the Commonwealth's southern border. The Appalachian Mountains, which dominate the western sections of Virginia, are the source of water for many of Virginia's major rivers and the location for most of its famous springs.

In a typical year, Virginia receives an average 42 inches of precipitation, 12 inches above the national average. Only a small portion of the total precipitation falls directly on the state's surface water. The remaining portion evaporates; runs off into streams, rivers, lakes and the ocean; or enters the ground and is taken up by plant roots or becomes groundwater. With the exception of the New River and the Potomac River, most of the water entering Virginia's streams falls within the state's boundaries.

Virginia is drained by nine major river basins. Two, the New and the Tennessee-Big Sandy, drain into the Mississippi River. Water from the other seven flow into the Atlantic Ocean.

DIVERSE beauty abounds. The running water of mountain streams and springs both above and below ground have formed such wonders as Natural Bridge in Rockbridge County, Natural Tunnel in Scott County, and Natural Chimneys near Harrisonburg in Augusta County. Groundwater has created approximately 1,790 caverns in Virginia. The state has a number of major waterfalls including Falling Spring Falls, Abrams Falls, Crabtree Falls, the Cascades, Twin Falls, Cedar Creek Falls, and Great Falls on the Potomac.

Virginia has only two natural lakes, Mountain Lake in Southwest Virginia and Lake Drummond in the Great Dismal Swamp in southeast Virginia. The state's many reservoirs, which cover more than 160,000 acres, were created by the damming of creeks and rivers to provide water supply, flood control, power generation, soil conservation, and recreation.

The Chesapeake Bay, into which the waters from five of Virginia's nine river basins flow, is the most sparkling jewel in the tiara of Virginia's waters. It is an avenue of commerce, a source of food, and a scenic wonder.

The waters of Virginia have played an important role in its economic and recreational development. From the early water-powered grist mills, to the canal systems built for waterborne transportation, and to the "healing waters" mineral springs, Virginia's waters have strongly influenced the development of the state.

The first public utility in the Colonial America was a ferryboat operation to carry citizens across Virginia's tidal rivers from the principal settlements to the outlying plantations. Ferry crossing points became the starting point for highways and roads. Later bridges spanned the rivers between these points. Today, nine historic wooden covered bridges still stand.

THE waters of Virginia are important to all of us. Water is as critical to our well-being today as it always has been. It is a necessity of life; it provides routes for transportation of goods, materials, and other resources; it promotes the growth of all our food sources; it powers much of our industry; and it is the source for most of our recreational pursuits. Water is the most common, most abundant, most useful to life of any of the substances known.

Although we often take water for granted and at one time called it an "inexhaustible resource," we know that water is a limited resource which is easily wasted, carelessly polluted, and always influenced by our activities. Virginia's waters are a precious resource. We hope that reading *Virginia's Waters* will increase your understanding and appreciation of them.

River Basins

GEOLOGISTS define a river basin—or watershed, to use the hydrologist's term—as the area drained by a river and its tributaries.

Exactly what constitutes a river or tributary, however, depends on one's point of view. For example, the Shenandoah River is a tributary of the Potomac when one is considering the entire Potomac River Basin. But when one studies the Shenandoah River Basin, the Shenandoah becomes the river and the North and South forks its tributaries.

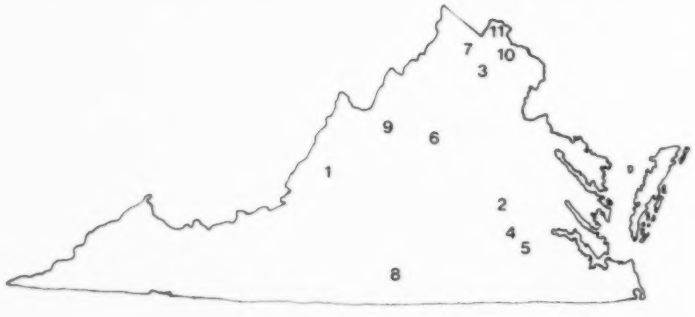
Within certain limits, then, how we define a river basin is subjective. For the sake of consistency, we have adopted the definitions of the Virginia State Water Control Board, the agency most responsible for managing Virginia's waters.

These river systems are as diverse as the geology and geography of the land through which they flow. At times their rivers flow gently, almost imperceptibly. At other times their rivers—as those of the James and Roanoke basins have demonstrated on three occasions since 1969—are capable of unleashing with incredible swiftness a destructive force of unimagined power.

There is a sameness to them as well. Their rivers flow through areas of breathtaking beauty and through areas that have been despoiled almost beyond repair by man. All have contributed immeasurably to the material and spiritual prosperity of the men and women who have settled on the banks of their rivers.

Twilight on the New River, Montgomery County (facing page).

Scenic Rivers Act: Preserving Our Heritage



THE SCENIC RIVERS ACT provides for the preservation of rivers or sections of rivers of exceptional natural beauty. Since its enactment in 1970, 11 sections of 10 rivers, totaling 225 stream miles, have been included in the Virginia Scenic Rivers System.

Inclusion requires the preservation of stream banks and surrounding areas and prohibits the building of dams or other structures that would impede the natural flow of the river in the designated section. Stream sections in the system are:

1. 14 mi. of the James from 2 mi. SE of Route 43 intersection at Eagle Rock to Route 60 at Springwood in Botetourt County.
2. 8 mi. of the James from Orleans St., Richmond, to city limits (Bosher's Dam).
3. 64 mi. of the Rappahannock near Chester Gap to Deep Run.
4. 6 mi. of the Appomattox in Dinwiddie and Chesterfield counties between Lake Chesdin and the Sussex-Southampton county line.
5. 33 mi. of the Nottoway in Sussex County between Route 40 intersection and Sussex-Southampton county line.
6. 26 mi. of the Rivanna in Fluvanna County from Albemarle County line to the James.
7. 14 mi. of the Shenandoah in Clarke County from the Warren County line to Lockes Landing.
8. 10.8 mi. of the Staunton in Campbell County from Long Island to Brookneal.
9. 6 mi. of the St. Mary's in Augusta County from the headwaters to the George Washington National Forest boundary.
10. 27.5 mi. of Goose Cr. in Loudoun County from the Fauquier County line to the Potomac.
11. 16 mi. of Catoctin Cr. in Loudoun County from Waterford to the Potomac.

River Basins in Virginia

Potomac-Shenandoah

Rappahannock

York

James

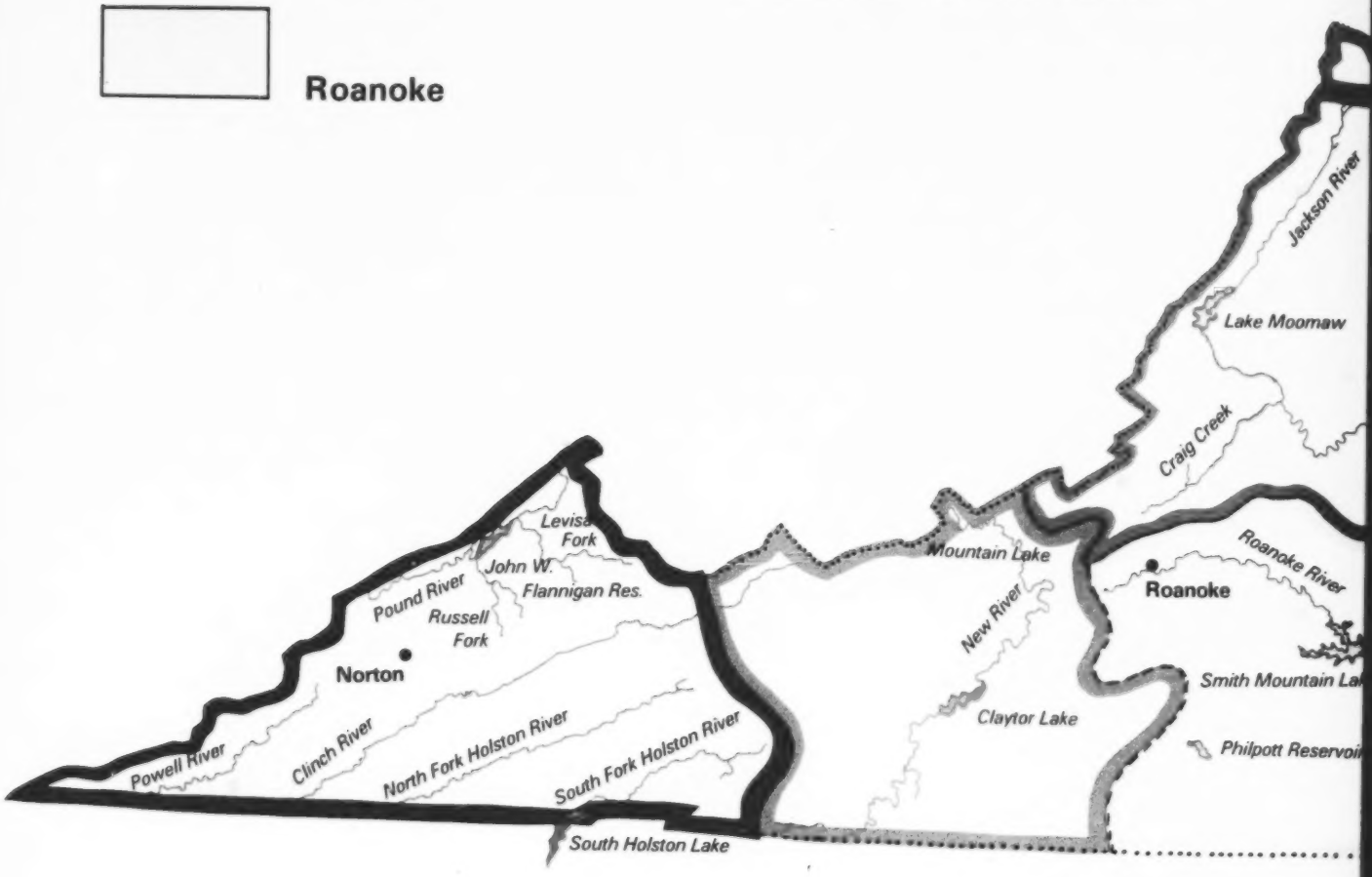
Roanoke

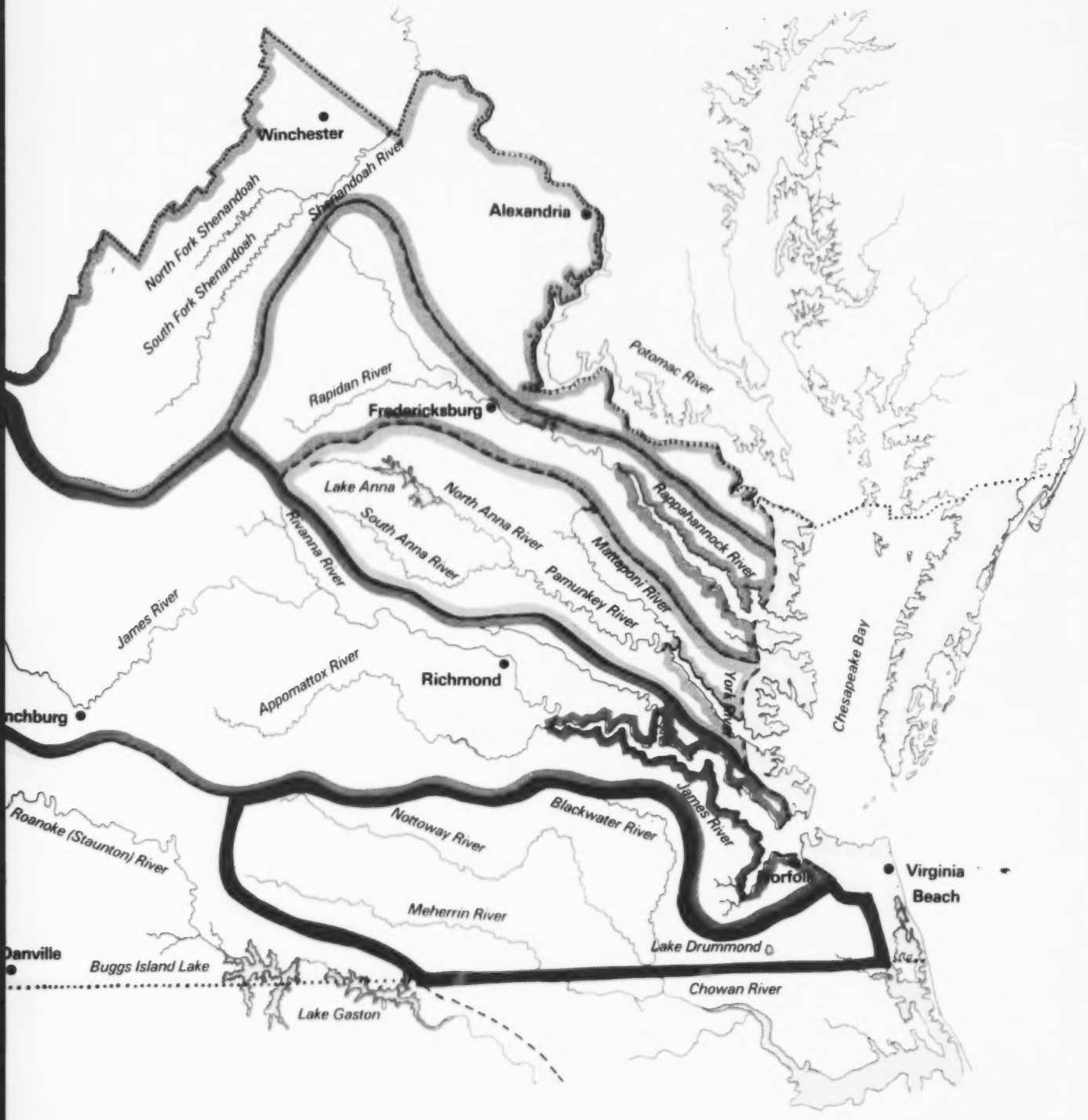
New

Tennessee-Big Sandy

Chowan

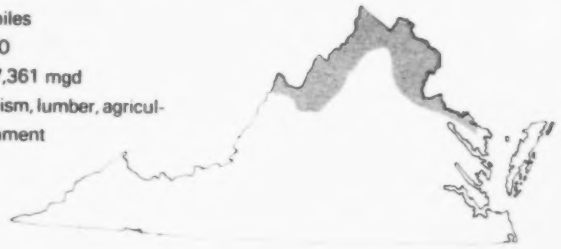
Coastal Rivers




Winchester
Shenandoah River
North Fork Shenandoah
South Fork Shenandoah
Alexandria
Potomac River
Rapidan River
Fredericksburg
Lake Anna
North Anna River
South Anna River
Rappahannock River
Mattaponi River
Pamunkey River
Rivanna River
James River
Appomattox River
Richmond
Chesapeake Bay
York River
James River
Blackwater River
Nottoway River
Roanoke (Staunton) River
Virginia Beach
Meherrin River
Lake Drummond
Danville
Buggs Island Lake
Chowan River
Lake Gaston

Potomac-Shenandoah River Basin

Area: 5,747 square miles
Population: 1,482,040
Average daily flow: 7,361 mgd
Major industries: Tourism, lumber, agriculture, federal government



THE waters of the "nation's river" begin as two small mountain springs. Originating near the southwestern tip of Maryland at the Fairfax Stone, the North Branch travels northeastward, forming the Maryland-West Virginia border. The South Branch, born in Highland County, Virginia, flows 133 miles through West Virginia to merge with the North Branch near Oldtown, Maryland, and form the Potomac.

The storied river touches Virginia soil again just below its junction with the Shenandoah, then surges out of the mountains, crashes over Great Falls, skirts Washington, D.C., and meanders southeastward until it ends its 383-mile journey at Point Lookout on the Chesapeake Bay.

About one-third of the Potomac Basin lies in Virginia, yet none of the river flows through Virginia. The ownership of the river has been a legal issue since King Charles of England made a grant in 1632 to Lord Baltimore of all the land of the Potomac region to the source of the river. Through a series of agreements and court decisions, the boundary between Virginia and Maryland has been fixed with the state line running along the Virginia side of the river.

Together with the watershed of its main tributary, the Shenandoah, the Potomac River Basin covers 14 percent of Virginia's land area and is home to nearly 30 percent of its population.

Although the portion of the basin in the Washington, D.C., area is one of the fastest growing areas of the nation, the Potomac and its tributaries are among the least developed rivers in the United States. About 94 percent of the basin is forest and farmland. Farming, and mining are vital elements in the economy of the basin. Fruit, grain, dairy foods, and tobacco are among the principal farm products.

INTENSIVE agriculture and the rapid growth in the Washington metropolitan area have taken their toll on the basin's water quality. Sediment and industrial wastes so polluted the river that President Lyndon B. Johnson in 1965 ordered a cleanup to make the Potomac "a model of beauty."

A marsh on the Potomac near Dahlgren.

The Potomac was one of the first rivers in the mid-Atlantic region to be explored by Europeans. Nearly 40 years before Captain John Smith's explorations in the early 1600s, the Spanish Admiral Pedro Menendez sailed up the Potomac to Aquia, near where Stafford is today. Both George Washington and Robert E. Lee were born along the river. Gunston Hall, the home of George Mason, father of the Bill of Rights, is also on the river, near Lorton.

The Potomac River was named by Captain John Smith after an Algonquian Village that was located near what is now Washington, D.C. Because of its easy navigability and access from the Chesapeake Bay, the river became the first highway to the western frontier in the Ohio River Valley. George Washington, among others, recognized the Potomac's potential as a commercial waterway. In 1785 the river was designated a common highway for navigation and commerce.

The completion in 1850 of the 195-mile Chesapeake and Ohio Canal along the north bank of the river boosted the economy of the region. Coal, lumber, stone, and foodstuffs were transported downstream to eastern communities and ports. Railroads eventually made the canal obsolete, and today it is a national historic park.

BECAUSE of its rich history, nearness to the nation's capital, and diverse physical characteristics, the Potomac basin supports profitable tourist and recreation industries. Each year, millions of tourists visit the basin's historic monuments, battlefields, national parks, forests, and mountains.

Most people associate the Potomac with Washington, D.C., or with Arlington (left) and the other densely populated suburbs that line the river near the nation's capital. In reality, much of the basin is sparsely populated — a fact that two sunbathers at the Great Falls of the Potomac (below) seem to appreciate.

THE main tributary of the Potomac has been celebrated as the most beautiful river in Virginia, one of the most pleasant rivers to canoe in the eastern United States and the greatest bass stream in America.

For three centuries this beloved river and the lush valley through which it flows have been called Shenandoah, a native American word for "Daughter of the Stars." Symbolizing the historic and cultural significance of the Great Valley beyond the Blue Ridge Mountains, the name Shenandoah is borne by towns, counties, ships, and a plaintive song.

The 150-mile-long river rises in two main forks in western Virginia. As it flows northeastward, the river drains about 3,000 square miles in seven counties before it joins the Potomac at Harper's Ferry, West Virginia.

The North Fork and the South Fork lie in two different sections of the Shenandoah Valley and are separated by Massanutten Mountain for 45 miles before joining near Front Royal. With the Blue Ridge Mountains to the east and the Allegheny Mountains to the west, the Shenandoah flows through an area of incredible beauty. Both forks of the river have some exciting white-water rapids, but, for much of their lengths,

The Shenandoah near Harper's Ferry.

Throughout Virginia's history, the Shenandoah Valley has been a rich agricultural area. Apples and peaches, for which it is famous, were first grown commercially in the nineteenth century. In 1983, the valley's Rockingham County led the state in agricultural goods, producing $213 million worth, including $130 million in poultry.

the Shenandoah and its tributaries meander peacefully around rolling hills. One segment of the North Fork makes 29 bends and covers 50 miles in the 20-mile stretch between Edinburg and Strasburg.

Because of its strategic location between two mountain ridges and its north-south orientation, the Shenandoah Valley was a significant avenue for Indian tribes, early explorers, settlers, and opposing generals of the Civil War. The paths of two principal native American trails are traced by Skyline Drive, which follows the crest of the Blue Ridge Mountains through Shenandoah National Park, and Interstate 81, which runs the length of the valley.

In the 1670s John Lederer, a German doctor, became the first white explorer to see the Shenandoah River. His trips were followed by the visits of fur traders and other explorers.

MOST of the settlers were German and Scotch-Irish immigrants, who moved southward from Pennsylvania in the early eighteenth century. Germans settled the middle valley and established, in the old world way, rich farms with isolated farmhouses and huge barns. Scotch-Irish immigrants moved into the more mountainous and less fertile sections of the valley. They became frontiersmen, hunters, and explorers. British Virginians from Tidewater also settled in the northern

section of the valley and retained their customs and plantation farming practices.

Many famous Americans have called the Shenandoah Valley home. Woodrow Wilson, Sam Houston, Daniel Boone, Cyrus McCormick, "Grandma" Moses, and John Marshall were from this area of Virginia. Among other notables, James Madison, Robert E. Lee and "Stonewall" Jackson lived and worked in the valley.

The valley was a significant military corridor and constant battlefield during the Civil War. Battles at Harper's Ferry in 1861, the Valley Campaign of 1862 by Jackson, the frequent and bloody battles of 1863, and the devastating raid by Sheridan in 1864 took their toll.

One episode in 1864 was especially tragic. As Union forces closed in on the Confederate positions, 274 young cadets from the Virginia Military Institute valiantly tried to hold off the "Yankee invaders" at New Market. Ten cadets and their professor were killed.

Following Reconstruction, farming in the area declined but orchards and pasturelands increased. As the mills returned to operation and the industries recovered, the old towns expanded into the cities of Winchester, Harrisonburg, Waynesboro, and Staunton. Eventually this urbanization and industrialization took its toll on the river's water quality. During the period from 1929 to 1950, a synthetic-fibers plant near Waynesboro released mercury into the waters. Today 102 miles of the South Fork Shenandoah and the South River, its tributary, remain contaminated. The ongoing harm to natural resources from the contamination prompted Virginia in 1983 to adopt a freshwater standard for mercury, the first state to take such action.

TOURISM and recreation have flourished in the area during recent years. Major attractions include the Shenandoah National Park, Skyline Drive, and George Washington National Forest. The river provides good fishing, swimming, and some challenging whitewater for rafting enthusiasts and canoers. Also of interest are a number of caves, unusual rock formations along the river banks, and the spectacular Natural Chimneys near Bridgewater.

Rappahannock River Basin

Area: 2,848 square miles
Population: 146,360
Average daily flow: 1.826 mgd
Major industries: Agriculture, tourism, fishing

SITUATED in northeastern Virginia, the 212-mile Rappahannock River begins in the central Virginia counties of Fauquier and Rappahannock and flows southeasterly to the Chesapeake Bay. Its river basin drains about 7 percent of Virginia's total land area. The river is navigable to Fredericksburg and at several points is seven miles wide. Major tributaries are the Rapidan, Robinson, Hazel, Thornton, and Corrotoman rivers, Mountain Run, and Cat Point Creek.

The river was named for a tribe in the area's powerful Powhatan Indian Confederacy. Derived from the river's tidal ebb and flow, the word Rappahannock means "People of the Alternating Stream."

The river is linked closely to the history of Virginia. From the Commonwealth's earliest time, it was an important route for transporting wheat, corn, and other supplies from its fertile lands upstream to coastal communities. During the 1600s, the region was the main area of economic and political development in Virginia, as the settlers built large tobacco plantations and established an aristocratic society. Small towns, warehouses and wharfs, inns and churches were constructed along the river to support the lucrative commerce of tobacco trade with England.

The prosperity of the plantation society made Fredericksburg an economic hub. Among the town's famous residents were the families of George Washington and Patrick Henry. James Monroe practiced law in Fredericksburg and John Paul Jones had a home there.

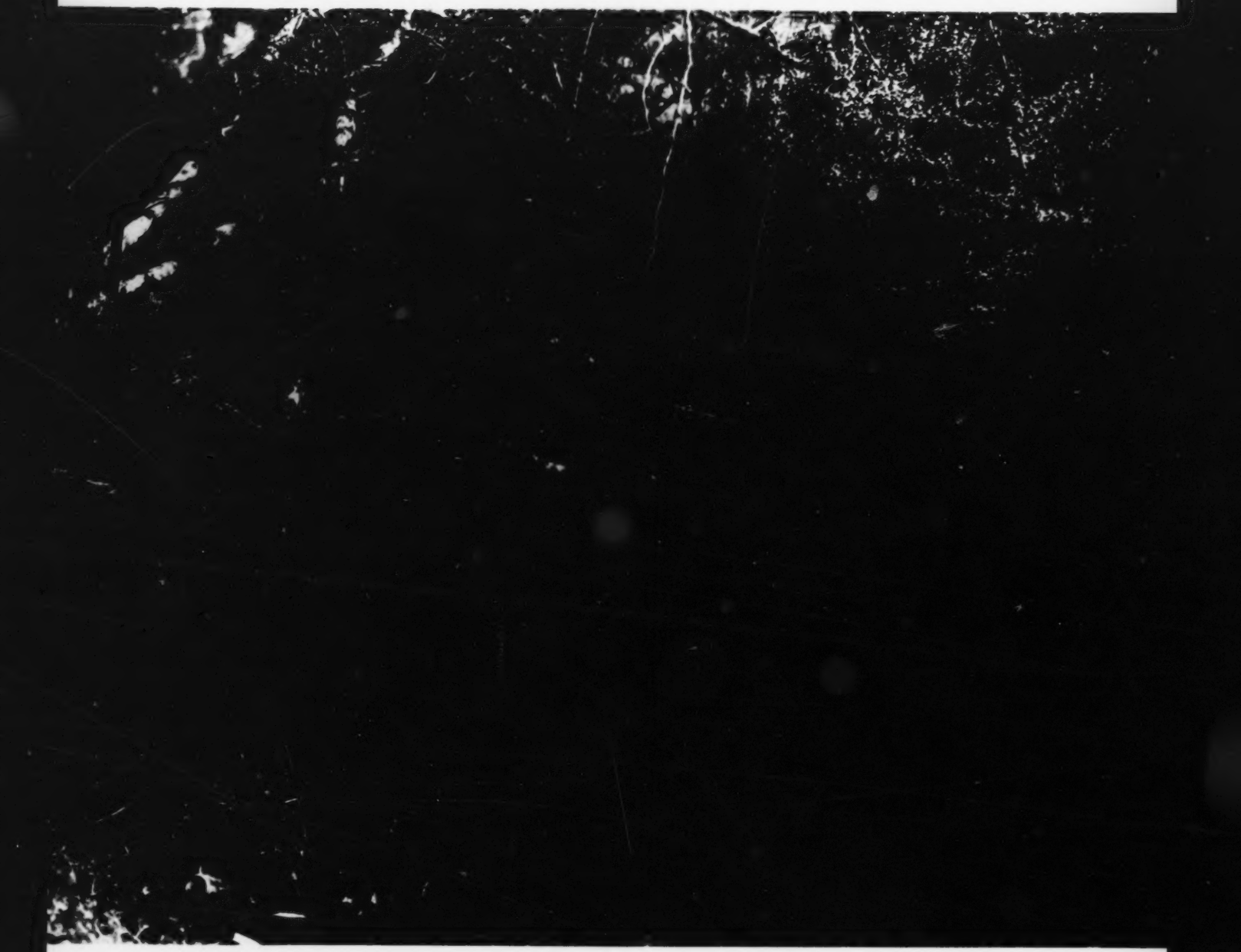
Some 20 miles downstream from Fredericksburg, James Madison, the nation's fourth president, was born on the banks of the Rappahannock across from Port Royal.

During the Civil War, the Rappahannock served as a barrier between the Union and Confederate forces and was used to ship troops and supplies. Some of the heaviest fighting of the war took place around Fredericksburg, especially during 1862 and 1863. In the Battle of Fredericksburg, General Robert E. Lee defended the city with 60,000 men against the Union army of 130,000. There were over 20,000 casualties. Other notable battles were at Spotsylvania Court House, Wilderness, and Chancellorsville, where General T.J. (Stonewall) Jackson was killed.

TODAY, the basin remains primarily a rural area, with forests covering 52 percent of the land and cropland and pasture covering 35 percent. In spite of its nearness to Richmond and Washington, only 2 percent of the region is classified as urban. Tourism, farming, and fisheries form the region's economic base, but certain localities, particularly Fredericksburg and Fauquier County, have been under going rapid commercial development and population growth in recent years.

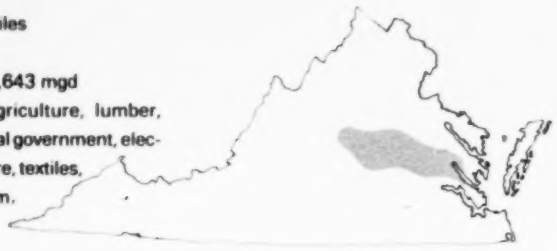
Twilight on the Rappahannock in Lancaster County (facing page).

Redbud in bloom on the banks of Mill Pond in the York river Basin.



York River Basin

Area: 2,661 square miles
Population: 116,262
Average daily flow: 1,643 mgd
Major industries: Agriculture, lumber, paper making, federal government, electrical power, furniture, textiles, shipbuilding, tourism, shipping



BOUNDED by the Rappahannock Basin on the north and the James Basin on the south, the York Basin covers about 7 percent of Virginia's land area. The basin is rural with about three-fourths of the land forested and nearly all the remainder in cropland and pasture.

The York River is formed by the merging of the Mattaponi and Pamunkey rivers at West Point, 34 miles from the mouth of the river. Major tributaries of the Pamunkey are the North Anna, South Anna, and Little rivers. The Mattaponi is formed by four tributaries, the Mat, Ta, Po, and Ni rivers. The York was first called "Pamunkee" by the Indians but was named York by the English in 1634 in honor of Charles I, Duke of York.

The average width of the York is about one-and-a-half miles. Because the York is a tidal river influenced by high seas and tidal surges, its entire length, from the Chesapeake Bay to West Point, is subject to tidal flooding. The greatest flood on record in the basin occurred in August 1969 when the remnants of Hurricane Camille dumped eight inches of rain and the North Anna River near Doswell rose 27 feet in seven hours. Although the basin experienced droughts in 1966 and in 1980-81, the most severe drought occurred in 1930-32.

Although no hydroelectric power generation occurs in the basin, steam-electric plants are located at Yorktown and at the Chesapeake Corporation's plant in West Point. Virginia Power operates a nuclear power facility on the North Anna.

The York's deepest point, about 83 feet, is at Yorktown, one of the state's best inland harbors. The Yorktown Harbor is significant in American military history. In the Revolutionary War, Admiral de Grasse blocked Cornwallis's attempt to escape by sea and forced him to surrender to the superior Franco-American land forces that had broken through his outer defenses at Yorktown. During World War I, the American fleet was anchored there. Today, two important military installations, Camp Peary and the Yorktown Naval Weapons Station, are located on the banks of the river.

The Yorktown Monument was erected in 1881 to commemorate the colonials' victory over the British 100 years earlier. Yorktown is incorporated in the Colonial National Historical Park, which includes nearby Williamsburg and Jamestown, and Cape Henry in Norfolk.

During the colonial period, the river was an avenue for the transport of timber, shingles, produce and tobacco, a mainstay of Virginia's economy at the time. Because of this profitable trade, a number of fine mansions and large tobacco warehouses were built along the river and its tributaries. Among these homes is a mansion on the Pamunkey River that was occupied by Martha Washington during her brief marriage to her first husband, Daniel Custis.

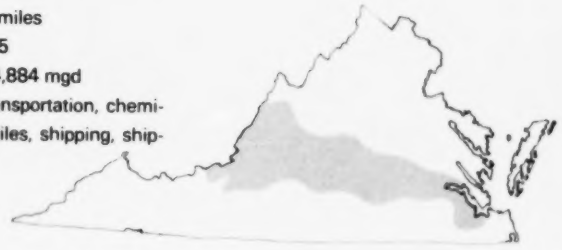
Eight miles south of the Pamunkey River at Lestor Manor is a 700-acre reservation owned by the Pamunkey tribe. The reservation is all that remains of the powerful Powhatan Indian Confederacy, which ruled over the tribes of eastern Virginia and Maryland at the time of the first English settlement in 1607. The peace treaty of 1640 with the Pamunkey Indians established the tradition of bringing gifts of game to the Governor's Mansion in Richmond.

The Mattaponies, descendants of a tribe once ruled by the Powhatans, own a reservation two miles east of the Mattaponi River.

THE York River is noted for its fishing. In colonial times, sturgeon, shad, spot, trout, and rockfish (stripers) were abundant. Oystering was also a major activity. Today, fishing in the Pamunkey and its sister river, the Mattaponi, still yields catches of hickory shad, stripers, perch, and pickerel. The Mattaponi is also a famous area for excellent waterfowl hunting.

James River Basin

Area: 10,102 square miles
Population: 1,718,945
Average daily flow: 4,884 mgd
Major industries: Transportation, chemicals, furniture, textiles, shipping, shipbuilding, tourism



THE JAMES RIVER is one of the longest rivers in the United States lying within the boundaries of a single state. Although 80 square miles in West Virginia are considered part of the watershed, most of the headwaters of the 340-mile-long river are in the mountains of western Virginia.

As the river flows southeasterly to Hampton Roads, where it empties into the Chesapeake Bay, it changes from a turbulent mountain stream west of the Blue Ridge to a sluggish tidal river below Richmond. The largest watershed in Virginia, the James River Basin includes all or part of 39 counties and 18 cities and drains one-fourth of the state's land area.

Probably no river is more deeply rooted in the history and traditions of the state than the James. The Indians of the area called the river "Powhatan" after the head of the powerful federation of tribes. English settlers named the river after King James I. Located along the lower James River were the first permanent settlements of English-speaking people in America and the birthplaces of two presidents, William Henry Harrison and John Tyler. More than a dozen colonial plantations still line the James.

Since the founding of the first permanent English colony at Jamestown in 1607, the river has supported agriculture and commerce. The first commercial canal in the United States was built on the James in 1785 by the James River and Kanawha Canal Company.

TODAY, major industries in the basin include transportation; lumbering; and the manufacture of chemicals, furniture, textiles, and apparel. The port of Hampton Roads at the mouth of the James is one of the nation's busiest. The river is navigable from the Chesapeake Bay to the falls at Richmond and has two inland ports: Richmond and Hopewell.

Nearly one-third of Virginia's population lives within the James Basin and uses its water resources. Because there are numerous high-density residential and commercial areas along the river, the demand for water from the James is great.

The James has been subject to water quality problems, including the infamous Kepone contamination from Hopewell to its mouth. Released from a chemical manufacturing operation at Hopewell between 1966 and 1975 Kepone severely contaminated aquatic life and river sediments, resulting in a series of restrictions on commercial and recreational fishing. One hundred thirteen miles of the river are still subject to commercial fishing restrictions because of Kepone contamination.

The most damaging floods in the basin were caused by extraordinary rainfalls from Hurricane Camille in August 1969, Hurricane Agnes in June 1972, and the remnants of Tropical Storm Juan in 1985.

Camille dumped an estimated 28 inches of rain in one night on parts of mountainous Nelson County. The ensuing flood killed 151, damaged 200 miles of highway and 133 bridges, and caused $116 million in property damage in Virginia. Several rural communities on the eastern slopes of the Blue Ridge were totally destroyed, buried under tons of mud, boulders, and uprooted trees.

THOUGH Camille was then thought to be the storm of the century, a mere three years later Agnes caused even greater flooding along the lower James. In the aftermath of Agnes, the James in Richmond reached its highest level since 1771, damages totaled over $37 million in the Richmond area alone, and 6,000 homes were severely damaged or destroyed.

Juan's damage was most severe in the upper James Basin, where Lynchburg and Buchanan were especially hard hit, and in the Roanoke River Basin. When the flood-swollen James crested at Richmond, it was nearly 31 feet above the flood stage, some five feet below the crest during Hurricane Agnes.

The most severe drought to occur in the basin was the drought of 1980-81, when streamflows at one point averaged 47 percent below normal and the James dropped to its lowest level ever.

A view of the James looking upstream from the Blue Ridge Parkway.

From a cascading stream near Peaks of Otter (below) and a stream with snow-lined banks in Albemarle County (left) comes water that feeds the James, shown on the facing page from a vantage point in Charles City County looking toward Hopewell. The James is not always so serene, however. Onlookers in Richmond watched as the James carried flood waters through Shockoe Bottom during the November 1985 flood.

Roanoke River Basin

Area: 6,284 square miles
Population: 597,833
Average daily flow: 5,218 mgd
Major industries: Agriculture, lumber, electrical power, tobacco, furniture, transportation

IN the seventeenth century, this 410-mile river was known as the Maratuck. Today, parts of it are known by two other names. From its headwaters to Leesville, and again from Buggs Island to Albemarle Sound, North Carolina, it is called the Roanoke. In the intervening stretch between Leesville and Buggs Island, the river is called the Staunton, after Captain Henry Staunton, a Revolutionary War soldier who commanded a company sent to protect settlers from Indians along that portion of the river.

Recorded history of the Roanoke-Staunton basin goes back to a year before settlement of the celebrated Lost Colony on Roanoke Island, North Carolina. In the spring of 1586, English explorers sent an expedition from Albemarle Sound up the Roanoke as far as Weldon, North Carolina. Settlement was not made far inland on the river, however, until probably a century later when John Lederer, a German, settled in 1670 near Altavista.

Although explorers and other settlers ventured into the basin after Lederer, a great migration to the region did not begin until the 1730s. Hoping to encourage settlement westward, the Virginia Assembly at that time promised 10 tax-free years to those who would settle in the Roanoke-Staunton River area. The population grew, as settlers found productive farming, grazing and hunting lands in the river basin. Among the area's notable residents was Patrick Henry, first governor of Virginia. His last home, Red Hill, stands on the banks of the Staunton River.

Mist rising from the Roanoke near the Blue Ridge Parkway — a scene that belies the fact that the basin is the most developed in the state with five major industrial centers of which Roanoke-Salem is the largest.

AS throughout the entire Virginia colony, tobacco cultivation and marketing played a major role in the settlement and development of the area, and tobacco became the region's chief money crop. After the War of 1812, the Roanoke River Valley became the center of the tobacco belt, and growers turned to the river as the most practical means for transporting this commodity to markets and ports.

In 1819, the Roanoke Navigation Company, an interstate organization chartered by North Carolina and Virginia, began construction of a series of canals to improve navigation on the Roanoke, Dan, and Banister rivers. By 1834, the company had constructed 360 miles of canals and made the lower Roanoke navigable for steamboats in North Carolina from Weldon to the river's mouth at Albemarle Sound — a distance of 100 miles.

In 1882, another form of transportation also began to influence development. Roanoke was selected as the terminal headquarters of the Shenandoah Valley Railroad and the newly reorganized Norfolk & Western Railway. Rail transport became the first major industry in the basin.

Extensive use of the Roanoke's water resources makes the Roanoke Basin the most developed river basin in the state today. The basin occupies 15 percent of Virginia's land area and supports several major industrial centers; Roanoke-Salem, Bedford, Danville, Martinsville-Henry County, and South Boston. Principal industries are textiles, furniture, building materials, and apparel manufacturing. Marketable mineral resources of the basin include mica, granite, coal, limestone, sand, and gravel.

The Roanoke basin is subject to severe flooding that causes high property damages because of extensive floodplain development. In November 1985, after several days of rain had thoroughly soaked the soil, Tropical Storm Juan dumped more than 6 inches of rain in the Roanoke Valley in 5 hours. The result was the most damaging flood in the Valley's — and Virginia's — history. Statewide, damage was estimated at more than $750 million. More than half that amount was recorded in Roanoke City, Roanoke County, and Salem.

THE Roanoke River Basin is rich in fish and wildlife. One wildlife enthusiast claims that the basin has the richest and most unusual fauna of any East Coast river. Among the bird, mammal and fish species that have been proposed for federal protection as endangered or threatened species are the Roanoke logperch and the orangefin madtom — both found in the North and South forks of the Roanoke.

Most anglers agree that the Roanoke offers some exceptional fishing, especially the annual spring run of spawning striped bass that make their way upstream to Brookneal during April and May. The river also offers good smallmouth bass, rock bass, and trout fishing.

New River Basin

Area: 3,070 square miles
Population: 217,724
Average daily flow: 3,237 mgd
Major industries: Lumber, agriculture, electrical power, coal, limestone, furniture, textiles, chemicals

SOUTHWESTERN Virginia's New River has the distinction of being one of the oldest rivers in the world, formed even before the Appalachian Mountains.

Unlike most rivers in the eastern seaboard states, which flow toward the Atlantic Ocean, the New River flows generally northward over its 320-mile length and it ultimately empties into the Mississippi River.

The name of the river has been a source of conjecture. The Indians called it the Kanawha, and one theory states that German settlers gave the river its present name by shortening Kanawha to Nawa, then New. Another theory holds that the river was so called because it flowed in a "new" direction. Seventeenth-century English settlers knew it as Wood's River, named for Abraham Wood, whose expedition encountered the river in 1671.

The New's course is similar to that of the ancient Teays River, the principal river of North America until the coming of the ice age, when glaciers covered large portions of the Teays Valley to the north.

HUNDREDS of tiny North Carolina streams in the Blue Ridge and Iron Mountains form the New River. It then flows 87 miles through Virginia before entering West Virginia, where it joins the Gauley River to form the Kanawha, which eventually enters the Ohio, one of the principal tributaries of the Mississippi.

Virginia's portion of the New River Basin occupies 8 percent of the state's total land area, and is primarily rural — 55 percent forest and nearly 45 percent cropland and pasture. Although industrial development encompasses less than 1 percent of the basin's area, the river does support several large industries and power-generation facilities. Appalachian Power Company operates one of its largest steam-electric generating plants at Glen Lyn near the West Virginia border. Other industries are the mining of coal, primary metals, and limestone, and the manufacturing of furniture, textiles, and chemicals. Water withdrawals from the river are greatest for power generation and industrial use, followed by public water supplies and agriculture.

A covered bridge spanning Sinking Creek where it crosses Virginia Route 601 near Newport. It is one of nine covered bridges left in the state.

Although tropical storms generally do not affect the basin, the remnants of hurricanes moving over the region caused large floods in 1861, 1878, 1916, and 1940. The storm of 1940 dropped 10 inches of rain in a 24-hour period and caused the greatest flood recorded on the New River. The New River Basin experienced its most severe drought in 1930 when rainfall averaged 18 inches below normal for the year and drought conditions were classified as extreme for nine consecutive months.

HISTORICALLY, the New River Basin remained relatively isolated until a railroad was built in the mid-nineteenth century. Though fur traders and land agents passed through the area, the population grew slowly and early settlements were sparse. Among the first were German and English settlements around what is now Blacksburg.

Relations between the settlers and native Shawnee Indians were turbulent. The story of Mary Draper Ingles, dramatized in Radford's outdoor historical play, *The Long Way Home,*

Climbers enjoy a view of the river near Radford. Steep cliffs carved over millions of years mark much of the New's passage through Southwest Virginia.

colorfully illustrates the area's pioneer conditions. Captured by Shawnees in an attack on the settlement in 1755, Ingles eventually escaped and made her way back to present-day Blacksburg from what is now Cincinnati.

Because many westward-bound pioneers came down the Shenandoah Valley and through the New River Valley, the route became known as the Wilderness Trail. Much of the basin's population is still concentrated along what was once the Wilderness Trail, which U.S. 11 approximately follows today.

The area's isolation did much to shield it from the ravages of the War Between the States. The expansion of the railroads in the decades after the war opened up the basin to settlers, travelers, and industrialists. This accessibility allowed commercial marketing of the basin's rich mineral and forest resources and the formerly isolated wilderness began to be developed.

THE NEW RIVER Basin is still among the least populated Virginia river basins, however, and the watershed includes thousands of acres of rugged, undeveloped terrain. The New River descends 1,000 feet as it flows through Virginia, making it one of the most challenging rivers in the East for whitewater canoeists and rafters. Touted as the state's best walleye stream, the river also abounds with bass, muskie, crappie, bluegill, and channel cat.

Tennessee-Big Sandy River Basin

Area: 4,140 square miles
Population: 319,526
Average daily flow (Tennessee): 2,966 mgd
Average daily flow (Big Sandy): 877 mgd
Major industries: Coal, lumber, tourism

THE Tennessee and Big Sandy rivers are fed by numerous mountain streams in Southwest Virginia, but both rivers form outside the state and eventually flow into the Ohio River. The Tennessee forms near Knoxville at the confluence of the Holston and French Broad. Principal Virginia tributaries are the Clinch, Powell, and Holston rivers. The Big Sandy forms near Louisa, Kentucky, at the confluence of its two principal tributaries, the Tug and Levisa forks. Virginia rivers that feed the Big Sandy include the Pound River, Russell Fork, and Levisa Fork.

The mountain tributaries that form the Tennessee and Big Sandy flow through narrow valleys bordered by steep, rugged ridges. These two river basins are so similar that this area in the westernmost tip of the state is called the Tennessee-Big Sandy region. It encompasses 10 percent of Virginia's total land area.

The Tennessee Basin drains 40,910 square miles in three states. Together these basins drain all or portions of 12 Southwest Virginia counties.

Almost half the land that the Tennessee drains in Virginia is forest-covered, and Virginia's portion of the Big Sandy Basin is 87 percent forested. Lumbering is important to the region's economy, although not so much as in earlier times when rafting timber down the rivers was one of the few ways to earn cash.

Coal deposits were noted as early as 1782 by Thomas Jefferson, and today coal mining constitutes the major economic resource of the area. In the Big Sandy Basin, Buchanan County is the state's leading coal-producing county.

Often called the "Highlands of Southwest Virginia," the area's history is closely linked to frontiersmen who settled the forested land of steep ridges and rocky gorges. The Cherokee Indians first inhabited this area, and Indian raids and treaties limited early white settlement.

In fact, because the area lacked fertile farmland, and high mountains prevented easy access to trading centers in the eastern part of the state, the region remained sparsely settled until after the Revolution.

Early hunters, traders, and explorers traveled through this area following the river valleys. Daniel Boone is said to have crossed the Blue Ridge Mountains for the first time in 1760 and to have hunted in the Holston River Valley. In the late 1770s, the country was opened to white settlements and the more fertile valley lands along the rivers were occupied by farms and small villages. The Holston and Clinch rivers served as natural, easily accessible highways and small settlements developed along their banks. About 1770, Evan Shelby and his son Isaac established a store on the South Fork Holston. The settlement that grew up around this enterprise became the border city of Bristol, Tennessee-Virginia.

During the 1780s, the first major industry in the area was iron smelting to produce nails, an important product on the frontier. Nails, lumber, and agricultural products were floated down the Holston to Knoxville.

In 1858, when the East Tennessee and Virginia Railroad was completed between Bristol and Knoxville, the railways lessened the importance of the Holston River as a major trade route. During the Civil War, the salt industries in Virginia and eastern Tennessee revived the river's importance. Although there were no major campaigns in this area during the Civil War, both Confederate and Union troops used the Holston and Clinch rivers for transporting troops and provisions.

AFTER the Civil War, the Wilderness Road that led through the Clinch Valley to Cumberland Gap remained a major American thoroughfare to western land. However, it was not until the late nineteenth century, when railroads were built into remote areas of Appalachia to carry out the coal, that the Tennessee-Big Sandy region of Virginia began to develop.

Big Stone Gap on the Powell River typifies mining towns that came into existence as the result of exploitation of the area's mineral resources. Established by John D. Inboden, a former Confederate general, Big Stone Gap prospered until the depression of the early 1890s.

The people of this area are vividly described in the 1908 novel, *The Trail of the Lonesome Pine* by John Fox, Jr., of Big Stone Gap. The book tells the story of a young engineer's love for a mountain girl and the feud of the Tolliver and Falin clans.

The waters of this region were of great value to the people settling the area, and they also learned to respect the rivers, because floods are frequent and often severe in the steep terrain of this region.

The most recent major flooding was caused by a 4-day storm in April 1977 which dropped from 5 to 15 inches of rain and caused record

floods. Major rivers crested at heights of 15 to 20 feet above flood level. The torrential rain caused extensive mudslides and the raging water destroyed or damaged 5,000 homes, 515 small businesses, 89 bridges, and miles of highways. Twelve southwestern counties and the City of Norton were designated a federal disaster area. Damage was estimated at over $237 million.

Although the waters in the area of the Tennessee-Big Sandy generally are clean, 81 miles of the North Fork Holston are contaminated by mercury released from an industrial operation near Saltville. Acid mine drainage and sedimentation from erosion of mined areas are problems in some of the small streams in the area.

Virginia's Tennessee-Big Sandy area contains no large urban centers. This lack of development allows vacationers to enjoy thick forests, mountain terrain, and productive water, where anglers fish for largemouth and smallmouth bass, sunfish, walleye, and crappie. The state's highest point, Mt. Rogers — 5,729 feet above sea level — is part of the Mt. Rogers National Recreation Area in the Jefferson National Forest.

THE South Holston Reservoir, North Fork of Pound Lake, John W. Flannagan Reservoir, and Scott-Wise Lake provide recreational opportunities as do the small lakes found in Hungry Mother State Park, Clinch Mountain Wildlife Management area, and Hidden Valley.

Natural area preserves are located throughout the region. Mountain waterfalls are plentiful and scenic, such as Abrams Falls near Bristol. Of special note is the Breaks section of Russell Fork, known as the Grand Canyon of the East and part of the Breaks Interstate Park on the Kentucky border.

Water skiier on South Holston Lake, Washington County (above). Coal processing plant on Levisa Fork, Buchanan County (below).

Chowan River Basin

Area: 3,558 square miles
Population: 150,377
Average daily flow: 2,160 mgd
Major industries: Agriculture, lumber, tobacco, meat packing, paper making

THE CHOWAN RIVER has been called Virginia's "interstate" river because a major portion of the basin is located in Virginia, but the river forms on the Virginia-North Carolina boundary and flows into Albemarle Sound in North Carolina.

Virginia's portion of the Chowan River Basin is located in the southeastern part of the state, and it drains 10 percent of the state's land area. The basin's terrain includes the rolling hills of the Piedmont and the flatlands of the Coastal Plain.

The Chowan's three main Virginia tributaries are the Blackwater, Nottoway, and Meherrin rivers. The Nottoway and Blackwater join at the Virginia-North Carolina state line to form the Chowan. The Meherrin River joins the Chowan 12 miles downstream. Largely rural, the Chowan Basin is 67 percent forested and 25 percent cropland and pasture.

The Blackwater River originates just south of Petersburg in Prince George County and flows southeasterly for 105 miles before it meets the Nottoway River. The Blackwater is named for its color, which is the result of tannic acid it receives as it passes through swamps and forests.

The Blackwater also flows through productive agricultural lands where tobacco, peanuts, and soybeans are the main field crops. The area is well known for hog production and meatpacking. Smithfield hams are a famous Virginia product. Lumber and other wood products also are important to the economy of the area. A large paper mill is located in Franklin on the Blackwater.

The Blackwater River Basin has many points of interest and some of Virginia's oldest settlements. Smith's Fort in Surry County was built in 1609, and other settlements in the basin date back to 1613. What is said to be the oldest brick building in English America, St. Luke's Church in Smithfield, was built in 1632.

The Nottoway River rises in Lunenburg County and drains the central portion of the Chowan River Basin as it flows southeasterly for 155 miles before joining the Blackwater River. The Nottoway derives its name from an Indian word for "rattlesnake." Much of the land bordering the river is forested, but there are large areas of farmland in the basin.

Agriculture and forestry are the mainstays of the economy along the Nottoway. The river basin contains extensive swamp and old hardwood forests. Wooded swamp areas provide excellent spawning habitat for fish. Bluegill, pickerel, crappie, largemouth and smallmouth bass, rock bass and white perch can be found in the Nottoway. This pristine wildlife habitat is of great value and about 33 miles of the Nottoway in Sussex County are included in the Virginia Scenic River System.

The Meherrin River also rises in Lunenburg County and flows southeasterly, crossing the Virginia-North Carolina border five times before

emptying into the Chowan River. An Indian word meaning "an island" is the source of the Meherrin's name.

Like the Blackwater and Nottoway, the Meherrin basin contains rich forests and agricultural lands. The basin is largely rural with no large industries. Only two population centers, Emporia and Lawrenceville, are located on the river. Founded in 1888, St. Paul's College in Lawrenceville is the third oldest historically black vocational and industrial school in the United States.

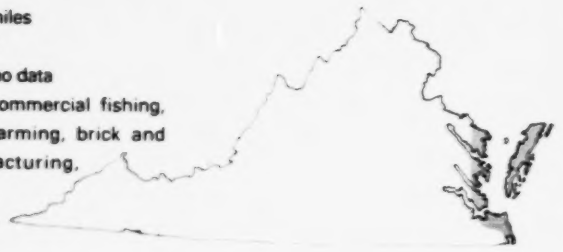
The Chowan River is named for the Chowanoke Indian tribe and means "southern people." The Chowan is a slow-moving river with a meandering 145-mile path through flat terrain that encourages swampy conditions. Its slow movement allows wastes and sediments to accumulate in the basin's stream channels. Excessive growth of algae, attributed to high levels of nitrogen and phosphorus, has been a persistent water quality problem in the Chowan. The first major algae bloom appeared in the Chowan in 1972, and blooms have appeared periodically since then. The Chowan floods infrequently, but wind tides affect the entire river.

The waters in the Chowan River Basin offer great opportunities for recreation. In addition to the wilderness areas of cypress swamps and scenic forests, the Nottoway and Blackwater rivers are noted fishing streams and some sections are used for white-water canoeing.

The slow-moving Blackwater flows through the Otterdam Swamp on its way to the North Carolina border, where it joins with the Nottoway to form the Chowan.

Coastal River Basins

Area: 2,106 square miles
Population: 598,343
Average daily flow: no data
Major industries: Commercial fishing, shipping, truck farming, brick and fertilizer manufacturing, poultry, tourism, federal government



THE Coastal River Basins include a number of rivers and streams that are short in length and have small drainage areas compared to Virginia's eight major river basin systems. Most of these Coastal Plain rivers are bordered by marshlands and flow into the Chesapeake Bay. Tides and wind-driven currents push water from the bay up into these coastal rivers, mixing salt water and fresh water and distributing nutrients throughout the estuarine system. Virginia's Tidewater region gets its name from the twice-daily tidal rise and fall of these watercourses.

Much of the drainage area is only a few feet above sea level and most of the land is either marsh, farm, or forest. The area is defined by five peninsulas. The western shore of the Chesapeake Bay consists of four peninsulas: the Northern Neck, which is between the Potomac and Rappannock rivers; the Middle Peninsula, between the Rappahannock and York rivers; the Williamsburg Peninsula, between the York and James rivers; and the Norfolk Peninsula, between the James River and the Atlantic Ocean. The fifth peninsula, known as the Eastern Shore, is actually the southern portion of the Delmarva Peninsula, which comprises nearly all of Delaware and parts of Maryland and Virginia.

Large rivers flowing into the Chesapeake Bay from the mainland peninsulas are the Great Wicomico River on the Northern Neck, the Piankatank and North rivers on the Middle Peninsula, the Poquoson River on the Williamsburg Peninsula, and the Lynnhaven River on the Norfolk Peninsula.

On the Eastern Shore, the Pocomoke River and Pungoteague, Occohannock, Nassawadox, and other creeks flow into the bay. The Machipongo River on the eastern part of the Delmarva Peninsula is the only river that flows directly from Virginia into the Atlantic Ocean.

The Coastal River Basins, which make up 4 percent of Virginia's total land area, include all of Accomack, Northampton, and Mathews counties and the City of Poquoson; and portions of Northumberland, Lancaster, Middlesex, Gloucester, and York counties and the cities of Norfolk, Virginia Beach, Hampton, and Newport News. The region also includes 18 barrier islands on the Atlantic side of the Delmarva Peninsula.

ONE of the results of the search for a northwestern passage to Cathay by sixteenth-century explorers was the discovery of Virginia's Eastern Shore. The first European to set foot there was Giovanni de Verrazano in 1524. As he looked out onto Chesapeake Bay, he was confident that he was seeing the western sea, an error perpetuated by map makers until the Spanish explorers DeSoto and Coronado proved the existence of land from Florida to California.

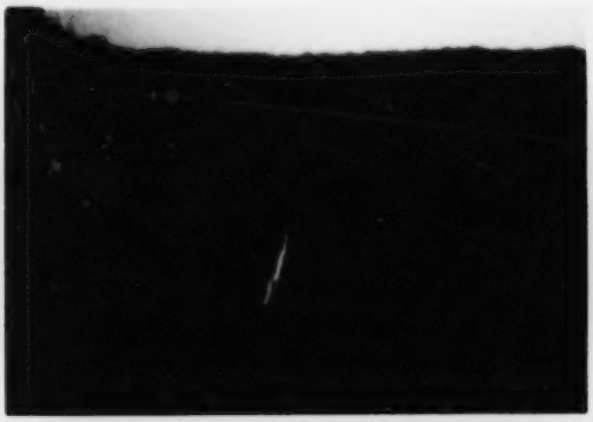
Settlement of the barrier islands and the Eastern Shore by European colonists did not occur until 1614. The entire peninsula was then called Accomack from the Algonquin Indian name, Acchwmake, "the land beyond the water." Accomack was one of the eight original counties of Virginia. It was along Pungoteague Creek that Anthony Johnson, a freed slave, became the first black landowner in America in the 1620s. The public records of the area are the oldest in America, dating back to 1632.

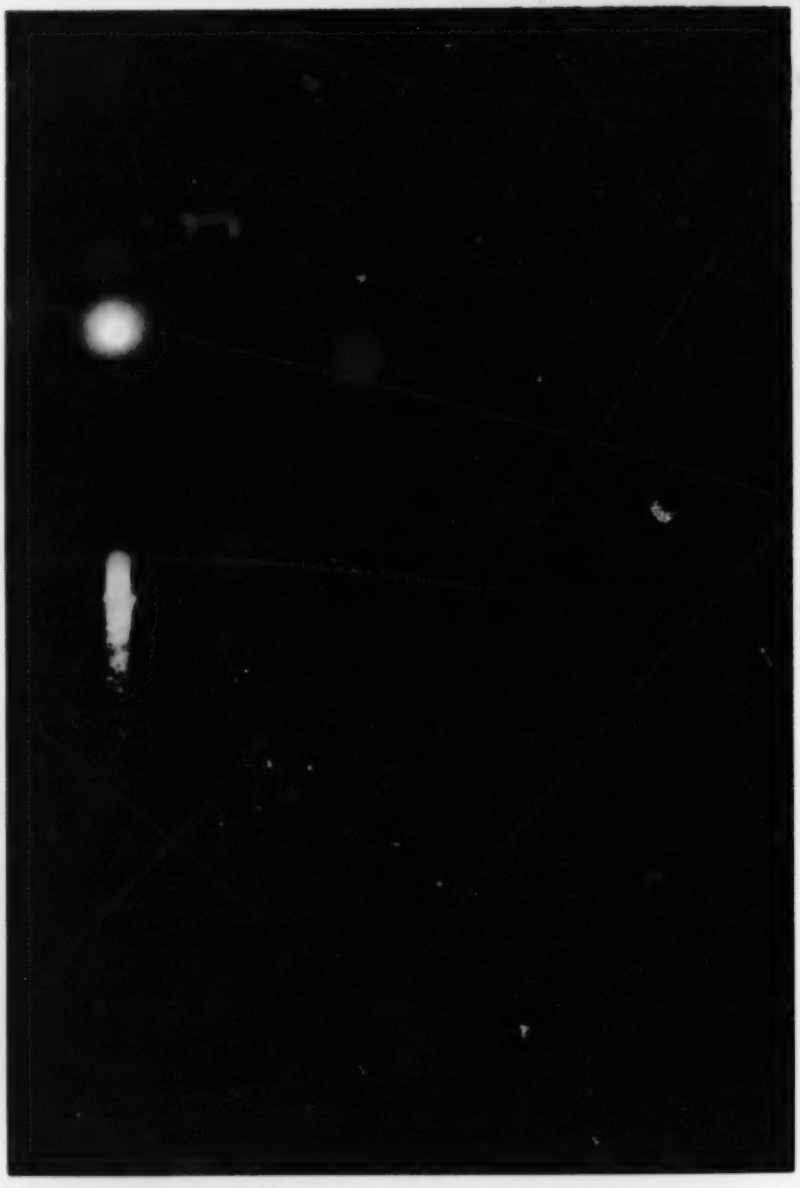
The New World's first public utility, a ferryboat to carry citizens across the tidal rivers from principal settlements to outlying plantations, was established in the Tidewater area in 1638. The first play produced in Colonial America was presented in Pungoteague in 1665.

Many of the counties and cities within the Coastal River Basins have historic homes, churches, and battlefields from the Revolutionary War, the War of 1812, and the Civil War.

Important industries in the Coastal River Basins include commercial fishing, shipping, truck farming, (especially potatoes, early vegetables, soybeans, corn, and hay), manufacturing of fertilizers from fish, brick manufacturing, and lumber products. Livestock, poultry, and seafood products are important contributors to the economy of the basin. Military installations are a major presence in this area.

Tourism at numerous historic sites





American egret in the Chincoteague National Wildlife Refuge (upper left). Marsh grass near Brownsville, Northampton County (upper right). Piankatank River at sunset (left). Elizabeth River (above).

Surf at sunrise, Hog Island.

and recreation areas are also major contributors to the economy of this region. Chincoteague, Virginia's largest island, is famous for the annual July roundup of the wild ponies that have lived on the island since the seventeenth century.

No discussion of the Coastal River Basins would be complete without mention of their highly productive marshes, which are among the world's richest ecosystems. Almost 90 percent of all the finfish and shellfish harvested by the Eastern Shore's seafood industry depend on coastal wetlands during at least part of their lives. These marshes provide feeding, nesting, and resting areas for over 275 species of birds, including great numbers of waterfowl and shorebirds. The marshes also provide pollution control by treating and assimilating excess nutrients and serve to control flooding by absorbing large amounts of water.

Protecting the marshes and shallow bays along the Atlantic side of the Eastern Shore is the nation's largest chain of undeveloped barrier islands. These islands, which parallel the coastline, are low and sandy with extensive tidal flats. They buffer the forces of winds, waves, and storm surges, thereby preserving the rich marshlands that separate the islands from the Eastern Shore. The Virginia barrier islands are largely managed by the Nature Conservancy and the U.S. Fish and Wildlife Service as wildlife refuges, providing a corridor of more than 45,000 acres of diverse coastal habitats.

Bays

"Pentaquod leaned forward with his paddle across his knees, content to allow his yellow canoe to drift quietly into the bay, and with each length that the log moved forward, he saw some new revelation: the immensity of this water, the way the fish jumped as if they were eager to be caught and tasted, the constant movement of birds back and forth, the majestic trees lining the shore, and over all, the arching sky more blue than any he had seen before."

— James A. Michener
Chesapeake

WITH about 4,400 square miles of water surface, the Chesapeake Bay is the largest of more than 800 estuaries in the United States and the largest body of water along the Atlantic Coast. It is some 200 miles long and ranges in width from 4 to 30 miles.

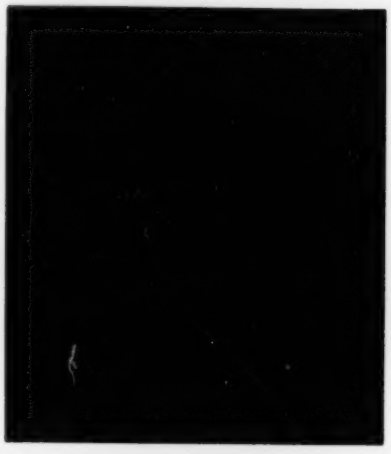
Of the 50 major rivers that feed the bay, five — the Susquehanna, James, York, Rappahannock, and Potomac — supply nearly 90 percent of the fresh water that flows into the bay. Draining more than 64,000 square miles in Virginia, West Virginia, Maryland, Delaware, the District of Columbia, Pennsylvania, and New York, the bay holds an estimated 18 trillion gallons of water. Despite this enormous amount of water, the bay is relatively shallow. Its average depth is less than 30 feet.

Thousands of years of geologic change have created the bay's physical characteristics. The landscape of the Chesapeake Bay region has been influenced by the repeated southward advance and northward retreat of massive glaciers. When the last major glacial period ended about 2,000 years ago, the melting ice raised the level of the sea along the Atlantic Coast. As the climate warmed over a period of thousands of years, broad expanses of the ancient Susquehanna River Valley and many of the river's tributaries were flooded. This flooded, interconnected system of streambeds and river channels now forms the floor of the Chesapeake Bay and adjacent tidal rivers.

The bay was named by the Algonquin Indians, who called it "Chesepioc," which means "Great Shellfish Bay."

Captain John Smith, who first explored the Bay in 1608 in preparation for English colonization, praised it as a paradise of abundant fish and fowl. Nearly four centuries later, the bay is still highly productive. Its major commercial seafood resources include softshelled crab, blue crab, oyster, clam, menhaden, and rockfish. The world's largest supplier of blue crab, the bay produces about 55 million pounds annually. Only the production of the Atlantic and Pacific oceans exceeds the bay's commercial fishery catch of more than $100 million annually.

Infrared photo of Chesapeake Bay.



Major industrial activities in the bay area are manufacturing, mining, shipbuilding, power generation, petroleum refining, chemical production, and meat, seafood and vegetable processing. The Chesapeake itself is a major commercial waterway that annually handles nearly 50,000 trips by commercial vessels carrying 90 million tons of cargo. Two of the five major U.S. East Coast ports are situated on the bay.

The port of Hampton Roads, which includes marine terminals at Portsmouth, Norfolk, Chesapeake, and Newport News, is located at the bay's mouth. In 1982, Hampton Roads was the largest export port in the nation; coal was the largest export commodity, and crude petroleum the largest import product. Other major products included grain, tobacco, lumber, and chemicals.

Located at the northern end of the bay, the port of Baltimore handles almost one-fourth of the East Coast's exports. The bay also provides access to Virginia's river ports of Hopewell, Richmond, and Alexandria.

The Chesapeake Bay seems to be everybody's favorite body of water, forcing government to walk a tightrope as it seeks to balance competing demands. For some, the bay is the avenue to Hampton Roads and Baltimore, two of the nation's busiest ports. Others follow a distinctive lifestyle while harvesting its finfish and shellfish. For an untold number of Americans, the bay is a watery playground offering sailing, swimming, sport fishing, bird watching, bird hunting, and other recreational pursuits.

Edward Born

AMONG the Chesapeake's most valuable contributions is its function as a supportive natural habitat for wildlife. Located within the bay region are 20 properties designated as national refuges or related properties. The bay's richly vegetated marshlands, combined with the productive waters of the tidal rivers, provide excellent wildlife habitat. More than 2,700 species of plants and animals, including 200 species of fish, are found in the waters and along the shore of the Chesapeake Bay.

Migratory birds use the bay and surrounding wetlands as a stop along the Atlantic Flyway. An estimated 500,000 Canada geese and more than 40,000 whistling swans winter in the bay area.

Among the multitude of birds that nest around the bay are black duck, wood duck, blue-winged teal, and the endangered bald eagle. The largest population of ospreys in the United States is located in the Chesapeake. Other birds found in the area include owls, gulls, hawks, herons, egrets, songbirds, and such game birds as wild turkey, quail, woodcock, dove, and pheasant.

The abundance of food and vegetation in lands adjacent to the bay provides ideal habitat for numbers of deer, fox, rabbit, squirrel, opossum, beaver, otter, mink and muskrat.

The bay also serves as a nursery and habitat for a number of finfish, many of which spawn in tributaries and areas of low salinity in the upper portion of the bay — bass, shad,

croaker, herring, menhaden, kingfish, and white perch. The bay is the primary East Coast spawning area for striped bass, a commercially important fish whose population has seriously declined in recent years.

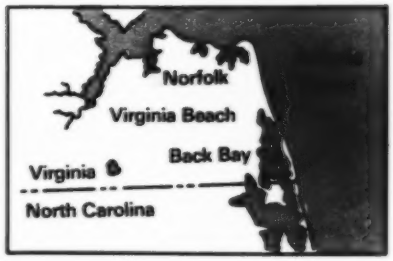
One reason for the area's high biological productivity is the 425,000 acres of marshland that fringe the Chesapeake Bay and its tributaries. More than half of these wetlands are in Virginia. Forming a natural boundary between land and water, these transitional areas contain salt water from the bay's tides and fresh water from groundwater seepage, streams, and rain. The marshes support an abundance of plant life, including wild rice, cattails, cordgrass, and needlerush. At least 10 species of bay grasses thrive here.

With the many miles of tidal shoreline along the Chesapeake Bay, Atlantic Coast, and adjacent estuaries and rivers, this part of Virginia is popular for its many recreational attractions. Water-based activities account for about half of the recreational time spent by Virginians, and the bay region offers ample opportunities for fishing, swimming, sunbathing, boating, camping, and hunting.

Since John Smith first explored the Chesapeake Bay area it has become a primary growth center along the eastern seaboard. The first settlers were attracted by the suitability of the region's soil and climate for tobacco cultivation. Later, the founding of the nation's capital and development of major manufacturing and transportation centers spurred population growth. By 1980, nearly 8.5 million people lived in the bay region.

Increased commercial, industrial, recreational, and urban activities throughout the Chesapeake watershed have put intense pressures on the bay's ecosystem, polluting the water and destroying wetlands. The effects of human activities and the conflicting demands on the bay's resources led Congress in 1976 to initiate the Chesapeake Bay Program to assess the bay's health and to make recommendations for improving water quality, and preserving living resources.

Although the bay and its tidal tributaries have remained productive in spite of the stresses inflicted by man, the future health and productivity of these waters and wetlands will be determined by how wisely the resources of the entire Chesapeake watershed are managed.



BACK BAY, a shallow, 25,000-acre coastal water body in the southern part of the City of Virginia Beach, is separated from the Atlantic Ocean by a narrow barrier beach. Averaging only 4 feet in depth, the bay is is dotted with small islands and surrounded by extensive brackish and freshwater marshes.

Back Bay is the northern arm of a huge estuarine system that includes Currituck, Albemarle, and Pamlico sounds in North Carolina. Back Bay and Currituck Sound receive drainage from Virginia Beach and Chesapeake via the Northwest River, the North Landing River, and many small creeks.

The southern end of the bay is tidally influenced and has brackish water. The northernmost part of Back Bay is a freshwater system, but the City of Virginia Beach pumps salt water from the Atlantic across the beach into this part of the bay to increase the bay's salinity and control milfoil, an undesirable aquatic grass.

Attracted by the enormous flocks of waterfowl that winter in Back Bay, sportsmen built a number of hunting clubs around the bay in the late nineteenth century. Commercial waterfowl hunting and destruction of wetlands in the ensuing decades led to a

Back Bay is both a birder's and fisherman's paradise.

sharp decline in waterfowl populations.

Since 1938, the U.S. Fish and Wildlife Service has protected 4.6 miles of beachfront just south of Sandbridge and the marshlands and bay waters to the west as the Back Bay National Wildlife Refuge. The remaining 5.6 miles of beach between the refuge and the North Carolina border make up False Cape State Park, a limited-access recreational area. The Commission of Game and Inland Fisheries also maintains three wildlife management areas for waterfowl hunting and fishing in Back Bay. The entire Back Bay-False Cape Natural Area comprises an 8,900-acre coastal wilderness of beaches, dunes, shrub thickets, wetlands, and open water.

Back Bay, known as a "birder's paradise," is an important feeding area for tens of thousands of birds that migrate along the Atlantic Flyway between Canada and Florida. It serves as the winter home of large numbers of ducks, geese, and swans. The bay is considered one of the best areas on the East Coast for largemouth bass fishing, and its shallow waters also support crappie, pike, pickerel, perch, and catfish. Biologists have counted more than 40 reptile, 30 amphibian, and 200 plant species in this ecologically rich area.

Lakes

VIRGINIA has more than 254,000 acres of publicly owned lakes and reservoirs, and an estimated 68,000 acres of privately owned farm ponds and lakes. Only two of the Commonwealth's lakes are not man-made: Lake Drummond in the Great Dismal Swamp and Mountain Lake in Giles County.

Natural Lakes

Mountain Lake is one mile long, about a fifth-of-a-mile wide, and 150 feet deep. Located in the Appalachian Mountains at an elevation of 3,875 feet, Mountain Lake is nearly 1,000 feet above most of the surrounding ridges and more than 2,000 feet above the New River, located 6 miles from the lake.

Because of the 60-acre lake's high elevation and dramatic fluctuations in its water level throughout recorded history, the lake's origin and the source of its water have been subjects of controversy. Large boulders of sandstone resting on a formation of shale at the north end of the lake are believed to have dammed up a stream that once flowed through the narrow valley to form the lake.

Today, no streams flow into the lake, but it is fed by precipitation and several springs on the lake's bottom. Water seeps through the lake's boulder dam into Pond Drain, which flows into Little Stony Creek then descends two spectacular waterfalls — the 20-foot Little Cascades and the 70-foot Cascades — and enters the New River.

The recorded history of Mountain Lake dates back to 1751, when Christopher Gist discovered the lake while he was exploring and mapping the area for the Ohio Land Company. Various eighteenth- and nineteenth-century accounts reported that the lake had dried up and cattle were driven there for the salt licks. In fact, until the late 1880s the lake was known as Salt Pond. Scientists believe that a period of prolonged drought between 1751 and 1805 could have caused an extremely low water level that allowed trees to grow on what is now the lake bottom. As the lake refilled, these trees were immersed and died. In the early 1900s, the trees were cut to prevent damage to boats, but the stumps are still visible today.

The first owner of the Mountain Lake area was John Chapman, who settled at the mouth of Walker's Creek in 1768. The lake and its environs became a private resort in 1856 and a clapboard hotel was constructed. Cottages were built around the lake in 1931, and the hotel was replaced in 1936 by one constructed of stone from a nearby quarry. The resort is now a popular vacation site for those who enjoy tennis, horseback riding, boating, fishing, and hiking in the relatively isolated area. An 11,000-acre spruce and hemlock forest adjacent to the lake was designated a wilderness area by Congress in 1984.

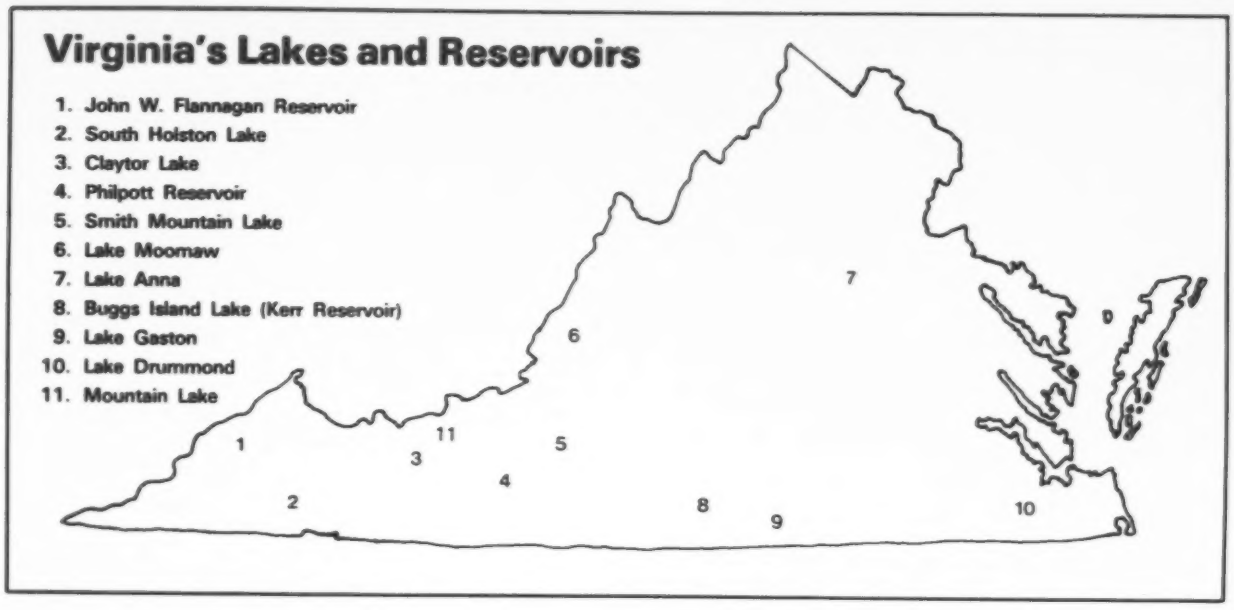
Lake Drummond, Virginia's other natural lake, is used for recreation and also serves as a source of water to maintain the level of the Great Dismal Swamp Canal, which is part of the Atlantic Intracoastal Waterway. The canal is the oldest surviving artificial waterway in the United States. The lake is located in the center of the Great Dismal Swamp, 50,000 acres of which have been designated a national wildlife refuge.

Lake Drummond is more than two miles wide and nearly three miles long, covering 3,180 acres. It was discovered by William Drummond, North Carolina's first governor, in 1665. The processes by which the shallow lake formed are uncertain, but it is believed to have originated about 4,000 years ago.

The Great Dismal Swamp surrounding Lake Drummond began forming along streams in the area about 12,000 years ago at the end of the last glacial period. As the climate warmed and the great continental ice sheets melted, the sea level rose and the swamp was enlarged, reaching full development approximately 3,000 years ago.

Some scientists believe the swamp once covered 1,400,000 acres. When the swamp was first accurately mapped in 1890, it had an area of 960,000 acres. Over the years, thousands of acres have been cleared of trees and drained for cultivation. Lake Drummond was 15 feet deep before commercial operations began to drain the swamp with canals and remove timber. The lake is now only six feet deep at the center.

A number of famous Virginians played an important role in the



history and development of this region. William Byrd surveyed the area in 1728 and gave the Great Dismal Swamp its name. In 1765, George Washington organized a company to build the first canal in the swamp to aid in lumbering operations.

Several decades later, Patrick Henry promoted the plan to build a 22-mile canal through the swamp to connect the Chesapeake Bay with Albemarle Sound in North Carolina. The Great Dismal Swamp Canal was chartered by the Virginia Assembly in 1787 and was opened to large vessels by 1814. The canal remained privately owned until 1929, when the federal government purchased it and the U.S. Army Corps of Engineers took over its operation. The canal is now the major water route into the Great Dismal Swamp National Wildlife Refuge.

The swamp is one of the few remaining large areas of wetland wilderness in the eastern United States. At least 35 different kinds of trees, including cypress, juniper, red maple, and wild cherry grow in the swamp. About 75 species of birds inhabit the area.

Reservoirs

Virginia has hundreds of man-made lakes and ponds that were created by damming creeks and rivers. The Roanoke River supports the largest number of major impoundments, with four man-made reservoirs that cover a total of 93,700 acres in Virginia and North Carolina. Buggs Island Lake (known as John H. Kerr Reservoir in North Carolina) is the Commonwealth's largest reservoir, although the lake does not lie entirely in Virginia. The largest lake wholly in the state is Smith Mountain Lake.

The watershed protection program of the U.S. Department of Agriculture's Soil Conservation Service has constructed reservoirs that impound 3,600 acres in the Commonwealth to control flooding and reduce soil erosion. The U.S. Army Corps of Engineers also operates four Virginia reservoirs that were constructed specifically for flood control: Flannagan, Moomaw, Buggs Island, and Philpott. South Holston Lake was built and is operated by the Tennessee Valley Authority for flood control and power generation.

Harrison Lake, Charles City County.

The principal reasons for the construction of other major Virginia reservoirs are (1) generation of hydroelectric power — Claytor, Smith Mountain, and Leesville (Appalachian Power Company) and Gaston (Virginia Power); (2) drinking water supply — Chesdin (Appomatox River Water Authority) and Occoquan (Fairfax County Water Authority); and (3) source of cooling water for nuclear power plant — North Anna (Virginia Power). Virginia's reservoirs also serve beneficial purposes other than their primary ones: they often help maintain stream water quality, regulate low flows, serve as recreation areas, and provide wildlife habitat. Of course, reservoir construction can have significant environmental impacts such as inundation of scenic, agricultural, or residential areas and disturbance of ecosystems. Hence, the costs and benefits of any proposed reservoirs must be carefully evaluated.

Groundwater

MORE than 50 spas with mineral or thermal springs once flourished in Virginia, mainly in the valleys and ridges west of the Blue Ridge Mountains. During their heyday in the nineteenth century, these springs were the summertime health and social centers of the Commonwealth. Visitors came from as far away as Europe to bathe in, drink, and rub themselves with the "healing waters" that flowed from these springs.

Touted as a treatment for almost every known ailment from indigestion to yellow fever, the mineral springs contain varying amounts of sulfur, sodium, calcium, magnesium, and iron. The thermal springs, at spas like Hot Springs and Warm Springs, are naturally heated deep within the earth to temperatures between 60 and 110 degrees Fahrenheit.

Only a handful of Virginia's spas remains today, but towns and communities in the springs region of Virginia still bear such names as Augusta Springs, Alleghany Springs, Sweet Chalybeate Springs, Orkney Springs, Healing Springs, Rockbridge Baths, and Yellow Sulphur Springs.

Groundwater, the natural resource that made Virginia's historic spas prosperous, is also responsible for the state's many caves and caverns. Carbonic acid, naturally present in groundwater, has hollowed out great limestone caves over thousands of years.

Nine caverns in Virginia, all west of the Blue Ridge, are open to the public. Scores of other caverns draw cave explorers to the western part of the state to investigate complex passageways, underground streams, rare bats, fossils, and exquisite rock formations.

The groundwater that creates these natural wonders has been an essential resource for Virginians throughout history and is critical for the Commonwealth's future.

Historians believe the first settlers at Jamestown relied on groundwater from shallow wells as their main water source. The colonists are said to have preferred the "sweet water" from the ground to the foul-tasting water from the brackish James River.

TODAY, about 400 million gallons of groundwater are withdrawn daily in the state for domestic and commercial use, industry, and irrigation. Major industrial uses include the processing of food, stone, and clay, and the manufacture of concrete, textiles, wood products, paper and chemicals.

Excluding the large amounts of surface water used to cool thermoelectric power plants, 31 percent of the fresh water used in Virginia is groundwater. About 80 percent of all Virginians use groundwater for at least part of their everyday water needs, including approximately 1.5 million state residents who obtain their domestic water supplies solely from private wells or springs.

What exactly is groundwater and where does it come from? Simply stated, groundwater is surface water that has seeped into the ground and has saturated earth and rock formations. A geologic formation that contains and transmits enough groundwater to supply wells and springs is an *aquifer*.

GROUNDWATER is one of the stages in the earth's hydrologic (water) cycle. In this cycle, water evaporates from the oceans and the land surface, then forms clouds and falls back to earth as precipitation. Some rainwater and snowmelt runs off into streams, but much soaks into the soil and seeps many feet underground to become groundwater. This process through which water percolates down from the earth's surface into aquifers is called *recharge*.

As shown by the hydrologic cycle, groundwater and surface water are closely connected. Surface water often becomes groundwater and groundwater often becomes surface water. Groundwater naturally appears at the earth's surface as springs. It also seeps into lakes, streams, and wetlands. In fact, 30 percent of the total streamflow in the United States comes from groundwater. During a drought, groundwater may be the only source of water for streams. Likewise, surface water from lakes and streams may seep underground and become groundwater. Surprisingly, far more fresh water occurs underground than in all the world's lakes, streams, and rivers.

VIRGINIA has five *physiographic provinces,* regions of characteristic geologic structure and climate: Cumberland Plateau, Valley and Ridge, Blue Ridge, Piedmont, and Coastal Plain. The terrain, soils, vegetation, and wildlife vary from one province to another. Less obvious to the casual observer, but just as distinct, are groundwater characteristics of each region. The natural quality and quantity of groundwater in each physiographic province depend on such properties as geology and rainfall. Human activities, such as land use, waste disposal, groundwater withdrawal, and irrigation, also have a profound impact on groundwater resources.

Cumberland Plateau

Portions of seven southwestern Virginia counties lie in the Cumberland (Appalachian) Plateau province. This hilly, sparsely populated region is made up of sedimentary rocks — sandstone, shale, and coal — that usually yield only small quantities of groundwater to wells. Groundwater quality in this area is often poor because of high iron or manganese content or acidity.

In addition to these natural groundwater quality problems, acid drainage from coal mines may contaminate groundwater and make it unsuitable for household use. Highly acidic water can corrode plumbing and leach toxic metals into drinking water, creating a serious health hazard.

Despite low well yields and water quality problems, localities in the Cumberland Plateau depend heavily on groundwater for coal processing and domestic use.

Valley and Ridge

Long, parallel mountain ridges separated by valleys are characteristic of the Valley and Ridge province, which stretches more than 300 miles from Winchester to Bristol. Limestone and dolomite aquifers in the valleys typically yield large amounts of water. Wells and springs yielding hundreds of gallons per minute are not uncommon. The water from these aquifers is often hard and requires softening for household use.

The connections between surface water and groundwater are most evident in the Valley and Ridge's limestone-floored valleys. Groundwater naturally comes to the earth's surface at hundreds of springs in the province, and these springs are frequently used for domestic water supplies. Weak natural acids in the groundwater dissolve limestone to form caves, channels, and sinkholes.

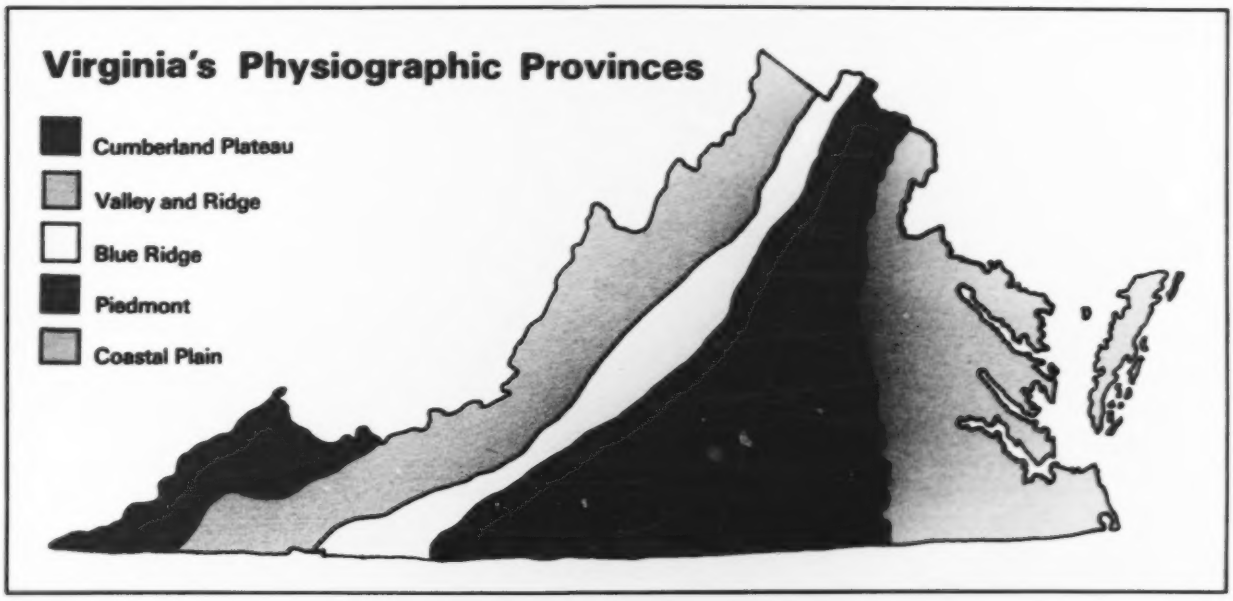
Groundwater in this region is extremely vulnerable to contamination because contaminated surface water often flows directly into the ground through limestone sinkholes. Ironically, sinkholes traditionally have been used as garbage dumps.

Blue Ridge

Virginia's highest mountain peaks are in the narrow Blue Ridge province. The region is a center for tourism and such outdoor recreational activities as hiking, hang gliding, fishing, skiing, and hunting. Much of the land in the Blue Ridge is owned or managed by the federal government.

The eastern flank of the Blue Ridge is composed of crystalline rocks such as granite and gneiss, while the western flank is made up of sedimen-

A once-flourishing resort at Yellow Sulphur Springs.



tary rocks like the neighboring Valley and Ridge province. Wells and many small springs in the Blue Ridge yield low volumes of groundwater, generally of good quality but, in some cases, requiring treatment to remove iron. The principal groundwater use is for private domestic supplies.

Piedmont

The Piedmont province is bordered on the west by the Blue Ridge Mountains, hence the name "Piedmont," which means lying at the foot of mountains. Within this province, which is made up mainly of crystalline rocks, the quantity and quality of groundwater are widely variable. Adequate supplies of potable groundwater for homes and farms can usually be found within a few hundred feet of the surface. In most Piedmont counties, groundwater accounts for 50 to 90 percent of total water use.

Well yields in the Piedmont commonly range from 3 to 20 gallons a minute; yields greater than 50 gallons a minute are exceptional. Larger yields may be obtained around extensive fracture and fault systems.

Coastal Plain

The Coastal Plain is bordered on the east by Chesapeake Bay and the Atlantic Ocean and on the west by the "fall line," an imaginary line running from Alexandria through Emporia that marks the limit of tidal influence on Virginia's rivers and streams and, on the larger rivers, the limit of navigability by ocean-going trading ships. Many of Virginia's earliest commercial centers, most notably Alexandria, Richmond, and Fredericksburg, were located on the fall line.

Today, nearly half of the state's groundwater use is in the populous Coastal Plain province, where large wells help supply the needs of industry and major public waterworks.

More groundwater is used for crop irrigation in the Eastern Shore's Accomack and Northampton counties than in all of Virginia's other counties combined. Poultry and produce industries are major groundwater consumers on the Eastern Shore.

The Coastal Plain, made up of layers of sand, gravel, silt, and clay, is the only physiographic province in Virginia that is composed mainly of unconsolidated deposits. Most small domestic wells in the Coastal Plain tap shallow aquifers less than 70 feet below the surface. These aquifers provide water of good quality, but they are highly vulnerable to pollution from surface sources since contaminants can seep rapidly through the porous, sandy soils to the groundwater.

Much larger, deeper aquifers — at least several hundred feet below the surface — supply industrial and public supply wells with approximately 160 million gallons a day. These aquifers, the state's largest, often produce well yields of more than 1,000 gallons per minute. By comparison, domestic wells in shallow aquifers generally yield 5 to 50 gallons a minute. (A well yield of at least 6 gallons a minute is usually needed for home use, though 10 gallons a minute is more desirable.)

Even though the Coastal Plain has huge quantities of groundwater in deep aquifers — one estimate is 3 trillion gallons — municipalities in populous Southeast Virginia are facing problems in meeting their water demands. Excessive withdrawal of groundwater from these aquifers has created a major decrease in groundwater availability around Franklin. Overpumping has also caused salt water, which occurs naturally beneath the ocean floor, to intrude westward into the freshwater aquifers. Groundwater pumped from deeper than 150 feet beneath Virginia Beach is too salty for household use.

Management

THE management of the state's water resources is a complicated and often confusing process. It is not the purpose of this publication to detail the many laws, court cases, and policies that affect the process. Instead, this section is intended to provide general information about the major laws and programs affecting Virginia's waters.

Thirteen state and nine federal agencies have authority to manage some aspect of the state's water and related land resources. In addition, interstate agreements and compacts have an impact on waters bordering the state.

A number of federal environmental laws provide protection for both ground and surface waters. These include the Safe Drinking Water Act; Clean Water Act; Resource Conservation and Recovery Act; Toxic Substances Control Act; Federal Insecticide, Fungicide and Rodenticide Act; and Comprehensive Environmental Response, Compensation and Liability Act (superfund). Many federal programs relating to land use practices also affect management of the quality and quantity of Virginia's water resources. Some involve national parks and forests, federal reservoirs, wildlife refuges, wilderness areas, scenic rivers, wetlands, and soil conservation activities.

Virginia relies on the common-law riparian doctrine for the allocation of surface water supplies. Under this legal doctrine, the right to use water depends upon ownership of land bordered or crossed by a stream. Water use is further limited to lands within the drainage basin where the water is withdrawn. The amount of water that a user can withdraw must be reasonable in relation to others with similar rights.

To date, the court decisions related to Virginia's groundwater are few, and the courts have not definitely stated which of the common law groundwater doctrines — absolute ownership or reasonable use — should be applied in the Commonwealth. Absolute ownership grants a landowner the unqualified right to use the groundwater beneath his land in whatever manner he sees fit.

The reasonable use doctrine, on the other hand, restricts the use of groundwater to the overlying land. The groundwater doctrine of reasonable use, unlike the riparian doctrine, does not require a sharing of water to accommodate others with similar rights.

VIRGINIA'S Groundwater Act of 1973 provides for the designation of groundwater management areas where (1) groundwater levels are declining; (2) the available supply is, or is about to be, overdrawn; (3) the groundwater is, or is in danger of, becoming contaminated; or (4) the wells of two or more users substantially interfere with each other. Within groundwater management areas, permits are required for commercial or industrial withdrawals that exceed 50,000 gallons a day. The designated management areas are (1) the southeastern corner of the state, including the counties of Isle of Wight, Prince George, Southampton, Surrey, Sussex, and the cities of Chesapeake, Franklin, Hopewell, Norfolk, Suffolk, Portsmouth, and Virginia Beach; and (2) the Eastern Shore, comprising Accomack and Northampton counties.

THE State Water Control Board (SWCB) is responsible for the Commonwealth's water quality control program and the administration and enforcement of the State Water Control Law. The SWCB is also charged with planning the development, conservation, and use of Virginia's waters. Currently, the SWCB is working with statewide and regional advisory committees to develop a water plan for the Commonwealth.

The State Health Department has responsibility for safe drinking water and other public health concerns related to water.

The Scenic Rivers Act, passed by the General Assembly in 1970, provides for the protection of rivers or river sections of exceptional beauty.

The process of including a river or river section into the system begins with studies by the Division of Parks and Recreation. Local citizen participation is encouraged in gathering data and support for the designation. After a study has been completed, the division publishes its findings, holds hearings, and makes a recommendation to the governor and General Assembly.

Claytor Lake State Park.

The law requires that an advisory committee of local residents assist and advise the Division of Parks and Recreation in the management of each scenic river. After the designation, no dam or other structure can be built that will impede the natural flow of the river. Preservation of stream banks and surrounding areas are required and development activities are restricted to assure the scenic river's "use and enjoyment" for its "recreational, geologic, fish and wildlife, historic, cultural, or other values."

Through 1985, 11 sections of 10 rivers, totaling 225 stream miles, have been incorporated in the Scenic Rivers System.

MAJOR issues and problems involving Virginia's water resources in the mid-1980s include interbasin transfers of water such as a proposed Lake Gaston-to-Virginia Beach pipeline, possible construction of a coal slurry pipeline across the state, siting of hazardous waste disposal facilities, comprehensive management of water resources through a withdrawal permit system, statewide standards for well construction, expansion of public water supplies to keep pace with rapid urban growth, control of agricultural runoff, and improvement of municipal sewage treatment operations.

The overall quality of Virginia's waters is rated as excellent by the SWCB, except in a few areas of the Commonwealth. Three large river segments have notable toxic pollution problems: a 113-mile stretch of the James River has seasonal commercial fishing restrictions because of contamination by the pesticide Kepone; 81 miles of the North Fork Holston River are restricted to catch-and-release fishing because of mercury pollution; and 102 miles of the South River and South Fork Shenandoah River are under a health advisory concerning fish consumption because or mercury contamination.

The extent and levels of water quality problems in the Chesapeake Bay still are being investigated even as the state begins implementing a 10-year program to address the bay's problems.

MANY local pollution incidents threaten Virginia's waters. Between July 1981 and June 1983, the SWCB and the U.S. Coast Guard investigated 969 oil spills in the Commonwealth. Fifty fish kills caused by pollution occurred during this period. An August 1981 waste discharge from two fish processing plants in Reedville killed 1.1 million menhaden. As of January 1, 1984, more than 80,000 acres of the state's shellfish waters were closed due to actual or potential contamination.

Since ground and surface waters are interconnected, groundwater is vulnerable to contamination that originates at the land surface. Some impurities may be filtered out of water as it percolates from the land surface to aquifers, but this is not always the case. Potential contaminants of Virginia's groundwater include sewage, petroleum products, hazardous waste, leachate from landfills, pesticides, fertilizers, livestock and fowl wastes, road salt, and coal mining waste. Three of the most common causes of groundwater contamination are malfunctioning septic systems. leaking underground gasoline or heating oil tanks, and poorly constructed wells that allow contaminated surface water to pass directly into well water.

GROUNDWATER contamination has become increasingly widespread in Virginia. The extent of groundwater contamination in the state is unknown, but several recent indicators suggest it is a growing problem. In 1985, the SWCB received 97 complaints about groundwater contaminated by petroleum products, seven times as many as it had received in 1979. The State Health Department analyzed household drinking water at 200 randomly selected wells in 14 south-central Virginia counties in 1983. The study revealed bacterial or chemical contamination that exceeded established drinking water standards in almost three-fourths of the water systems sampled.

Groundwater moves so slowly that human exposure to contaminated drinking water may not happen until months or years after the initial contamination. Cleaning up contaminated groundwater is usually expensive, often impractical, and sometimes impossible. For instance, if heating oil from an underground oil storage tank leaks into a family's well water, that well may never again be usable as a home water supply.

Although the General Assembly has given primary responsibility for the quality and quantity of Virginia's waters to state agencies, every citizen also has a personal responsibility to use Virginia's water resources wisely. To make well-informed decisions, Virginians need to understand the state's water resources, the issues and conflicts affecting water quality and use, and our interrelationship with the environment.

VIRGINIANS have control over the quality of the state's ground and surface waters. Land uses and many everyday activities affect water quality. By properly maintaining wells and septic systems and by being cautious about the use of hazardous substances — pesticides, fertilizers, herbicides, paints, fuels — and the disposal of all types of waste, every citizen can help protect our water resources.

Every Virginian can also play a part in ensuring adequate water supplies. Conserving water — simply using only as much as needed — is economical and may help prevent shortages in the future.

Residents of the Commonwealth have a responsibility to future generations to manage wisely and conserve the state's natural resources, so that the growth and progress of Virginia contributes to improved quality of life for all its citizens. The future of Virginia's waters remains in the hands of all Virginians.

The passage of the Patowmac through the Blue Ridge
is perhaps one of the most stupendous scenes in nature.

Thomas Jefferson
Notes on the State of Virginia

Virginia Water Resources Research Center
Virginia Polytechnic Institute and State University
Blacksburg, Virginia